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(54) Method and device for validating security papers

(57) Based on the incorporation in the security paper (1) of fibrils (2) of different colours, for example red, green and blue, visible with ultraviolet light, the paper is subjected to the effect of a system of illumination (2), with fluorescent lamps with ultraviolet radiation, and the images are captured by a video camera (4) the lens of which is provided with at least a filter (6) which lets pass exclusively the visible component of the spectrum, which feeds the images to a computer (5), provided with an acquisition card, computer in which a histogram is prepared of the images to obtain the most appropriate colour intervals, subsequently a threshold calculation to colour the pixels of the image which fall within the colour intervals corresponding to the fibrils of each colour, next an elimination of small particles from the image with a number of pixels lower than that predetermined, subsequently erosions and dilations to connect and to separate particles, subsequently a convolution stage, to highlight or to soften different aspects of the image, next a morphological analysis to establish the different control parameters, and finally the validation of the image with the objective of the system being capable of counting the fibrils incorporated in the security paper.

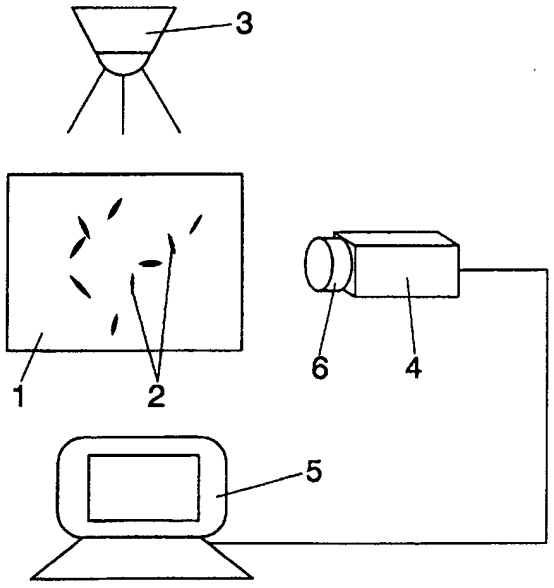

FIG.1

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Description

OBJECT OF THE INVENTION

[0001] The present invention relates to a control procedure that has been specially conceived to guarantee, by means of a specific characterisation, the paper used in the obtaining of different types of documents, like for example banknotes, in order to render impossible or more difficult potential counterfeiting thereof, based on the insertion inside the same of fibrils of different colours and in certain proportions.

[0002] The invention also concerns the device which allows the performance of said control and, in consequence, validation of the security paper as such.

BACKGROUND OF THE INVENTION

[0003] In the field of security paper, a great many solutions are known intended to characterise or personalise the same, which make more difficult its production or copying in a fraudulent way.

[0004] Within the multiple solutions of which mention has just been made, one of them consists in using fibrils which are included in the paper pulp, during the manufacturing process thereof, coloured, invisible with natural light but visible with ultraviolet light, so that by means of a certain combination of colours, like for example by means of the participation of fibrils of red, green and blue, in certain proportions, the intended personalization is achieved.

[0005] To date the validation of security paper with these components is carried out in a manual way, conducting a kind of sampling on some documents, using for this an appropriate ultraviolet light source and proceeding to the visual detection of the presence of fibres of the different colours and the counting thereof.

[0006] Obviously this solution is slow and laborious, with a high risk of error in the counting of the fibrils and with samplings which are frequently of scant significance, since the inherent laboriousness of the process does not admit the use of a high number of samples.

[0007] On the other hand and although the counting of the fibrils of each colour can be exact, using for this the time that is necessary, the uniformity or homogeneity in the distribution thereof depends on the criterion of each person that is carrying out the work, which does not allow an adequate precision in the control of this parameter.

DESCRIPTION OF THE INVENTION

[0008] Based on the use of fibrils of different colours visible only in ultraviolet light, the procedure of the invention consists in using a video camera as means of receiving the images, with its lens equipped with filters which permit the suppression of large peaks which are produced due to the radiation of the illuminating lamps, so that the light response of the fibrils covers the whole visible spectrum, different wavelengths are produced within the near infrared. The image captured by the aforementioned video camera is applied to a computer equipped with an acquisition card, with its corresponding computer program, wherein by means of a digital process the different fibres of the paper are analysed, separated and counted, in their aforementioned different colours.

[0009] In more specific terms, the following operational steps are carried out in the computer:

- Histogram of the image. Starting from the histogram for each group of red, green and blue fibrils, the most appropriate colour interval is obtained, that is, the interval of said histogram is maximised, sequentially for each of the three colours.

- Next the threshold calculation is carried out, that is, for the colouring of the pixels of the image which fall within the colour interval corresponding to each fibril group, in the also corresponding colour thereof, whilst the pixels that fall outside said intervals change to black.

- Next the subtraction takes place of the particles of the image that are of a size smaller than a predetermined number of pixels, so that noise and dust specks are eliminated, among other perturbations.

- Erosion and dilation are subsequently carried out, the objective of which is, on one hand to connect particles which being single have become separated in the image, and on the other to separate those that have been joined.

- Convolutions are subsequently carried out, applying filters (high pass, low pass) to highlight or to smooth different aspects of the image.

- Next a morphological analysis is carried out which allows the number of fibres of each colour to be discovered, as well as other parameters such as size, position, centre of gravity, etc.

- Finally the validation is performed of the image n accordance with the established program, which permits determination of whether the sample taken is or is not within the specifications, to be accepted or rejected.

[0010] The device for the performance of the mentioned procedure incorporates a system of illumination provided with two light panels with several fluorescent lamps with ultraviolet radiation, one of them located under the sheet of paper, to obtain backlighting, and the other placed in one of the lateral walls of the device, in a position perpendicular to the sheet, so that with the

help of a mirror located on the opposite face, a frontal and diffuse illumination is obtained. Logically, the device is provided with switches for general off/on purposes and for independent operation of each of the panels, in order to obtain two different illuminations to allow visualisation of both the figures located nearer one of the faces of the sheet and the figures which are deeper and therefore more difficult to visualise with a single source of illumination.

[0011] The device also incorporates a CCD camera, with adjustment of gain, colour temperature and reference white, with the aforementioned filter which only allows the visible component of the spectrum to pass, suppressing the infrared and ultraviolet components. Said camera sends the image captured in compound video format to the acquisition card incorporated in the computer, which allows adjustment of brilliance, contrast and saturation of image.

DESCRIPTION OF THE DRAWINGS

[0012] To complete the description that is being made and with the object of assisting in a better understanding of the characteristics of the invention, in accordance with a preferred example of practical embodiment thereof, accompanying said description as an integral part thereof, is a set of drawings in which, by way of illustration and not restrictively, the following has been represented:

Figure 1 shows, according to a schematic representation, the device for the control of security paper which the invention proposes.

Figure 2 shows, according to a view in perspective, a specific example of practical embodiment for the device of the previous figure.

Figure 3 shows, finally, a block diagram corresponding to the procedure of the invention.

PREFERRED EMBODIMENT OF THE INVENTION

[0013] In figure 1 a paper piece has been represented (1) with fibrils (2) of the aforementioned, red, green and blue colours, fibrils which will be visualized with the collaboration of ultraviolet light panels (3) the radiation from which is located in the range between 300 and 420 nm, this being the most appropriate radiation to produce a light response of the different fibrils, whereby the responses in wavelength are the following:

- Red fibres: 400 < 1 < 450 nanometres
- Green fibres: 450 < 1 < 550 nanometres
- Blue fibres: 550 < 1 < 680 nanometres.

[0014] Thus, the light response of the fibrils covers the whole visible spectrum.

[0015] The image produced on the paper (1) by the aforementioned illumination for the fibrils (2) is captured by a camera (4) and fed to a computer (5) equipped with a data acquisition card.

[0016] The video camera (4) incorporates in front of its lens a filter (6), to receive strictly or exclusively the images corresponding to the visible spectrum.

[0017] From the practical point of view and as figure 2 shows, the device is materialised in a casing (7) whereon un upper platform (8) is defined with a transparent area (9), for installation of the paper (1), under which is located a luminous panel (10) with several fluorescent lamps with ultraviolet radiation, in order to achieve backlighting of said paper (1), being mounted on the casing (7) and more specifically on the aforementioned area (9), a tower (11), vertically fluted, which is closed by means of a lateral cover (12), said tower (11) housing, at a lower level, a second luminous panel (13) of characteristics similar to that previously mentioned (10), which is located in a position perpendicular to the paper sheet (1), in such a way that with a mirror (14) located inside the cover (12) a frontal and diffuse illumination of the paper is obtained, collaborating with these luminous panels (10) and (13) is a control keyboard (15) also mounted on the upper base of the aforementioned casing (7).

[0018] In the upper area of the tower (11) and in a situation perpendicular to the paper sheet (1), the CCD camera (4) is located with its corresponding filter.

[0019] In a more specific manner the camera (4) will be a 3-CCD camera, with gain adjustment in RGB, and as previously stated with colour temperature and reference white among others, as well as with a filter which allows only the visible component of the spectrum to pass, suppressing the infrared and ultraviolet components.

[0020] The image captured in the camera (4) is sent, in composite video format, to the acquisition card of the computer (5), which allows adjustment of brilliance, contrast and saturation of the captured image. The image is captured at 24 bits (RGB) and with uncompressed BMP format.

[0021] The captured image is conditioned in the computer (5), applying different digital processes.

[0022] In a more specific manner and as is shown in the block diagram of figure 3, a histogram is first obtained of the image (16) for each group of red, green and blue fibrils, from which the most appropriate HSL (Hue, Saturation, Lightness) colour interval is extracted, specifically in the following manner:

- The histogram (H) is obtained of the image for the red fibrils.
- Within a precisely defined area (with a certain safety margin) the interval is sought where said histogram

reaches maximum.

- The two previous steps are repeated for the histograms (S) and (L).

- The process is repeated for the green fibrils and later for the blue ones.

- At the end an HSL interval is obtained for each fibril group with a procedure which is dynamic, that is, the interval obtained varies for each image, whereby the fibre search is optimised.

[0023] Subsequently a threshold calculation (17) is carried out, consisting in putting for the corresponding colour (red, green or blue) the pixels of the image which fall within the HSL intervals corresponding to the fibril group, whilst the pixels which are outside said intervals change to black.

[0024] Next a phase (18) of particle elimination takes place wherein the image particles are removed which have a size smaller than a certain number of pixels, in order to eliminate noise and dust specks, among other sources of interference.

[0025] Subsequently an erosion and dilation stage (19) is carried out, the objective of which is, on one hand to connect particles which being single have been separated in the image, and on the other hand to separate those that have been joined.

[0026] A convolution phase (20), applying different filters (high pass, low pass) allows highlighting or softening of different aspects of the image.

[0027] A morphological analysis (21) serves to discover the number of fibres of each colour, as well as other parameters like the size of the fibres, position, centre of gravity, etc.

[0028] Finally a validation (22) of the image is carried out, in accordance with a series of rules previously established so that the program can determine whether the sample analysed is or is not inside the specifications, thereby being accepted or rejected.

[0029] Before carrying out an analysis it is necessary to adjust certain parameters, specifically the illumination, and the positioning and size of the picture to be captured.

[0030] The adjustment of the illumination is carried out by means of a colour master, in such a way that for said master a certain HSL response has to be achieved. If the illumination is inadequate, the response will fall outside acceptable limits.

[0031] To fix the position and size of the image to be captured it is necessary to focus on a square calibrated to the size it is desired to capture, in such a way that the image is perfectly focused inside said square and with the limits thereof on the border of the captured image. In this way the pixels/nm ratio will always be the same when carrying out the morphological analysis.

[0032] For the actual analysis of the fibrils and after introducing the paper sheet (1) to be analysed under the system of illumination (3) one proceeds, by means of the program, to capture the image. Automatically said image will be analysed counting the number of fibrils of each colour and displaying them on screen. Additionally other results can be given, like the mean size of the fibres, the density of fibres and the percentage surface area occupied by them, among others. Both the image captured and the analysis performed can be stored and recovered later.

Claims

1. Procedure for control of security paper, which based on the use of fibrils of different colours, preferably red, green and blue, invisible in natural light, embedded in the paper, for subsequent visual detection thereof by means of illuminating the paper with ultraviolet light, is **characterised in that** it is capable of counting the fibrils present in the security paper, using for this as means of capturing the image of the fibrils (2) on the paper (1) a video camera (4) which feeds said images to a computer (5), provided with an acquisition card which allows adjustment of the brilliance, contrast and saturation of the captured image, at 24 bits and with uncompressed BMP format, the image captured being conditioned by means of the following digital processes:

   - obtaining, from the histogram of the image (16) for each group of red, green and blue fibrils, the most appropriate HSL (hue-saturation-lightness) colour interval, processing to obtain, independently and within each colour, the histogram for the gain, for the saturation and for the lightness with maximum value interval;

   - threshold calculation (17), consisting in providing the pixels of the image with the corresponding colour (red, green or blue), which fall within the HSL intervals corresponding to each group of fibrils (red, green or blue), whilst the pixels that fall outside said intervals change to black;

   - subtraction (18) of the particles of the image that have a size smaller than a certain number of pixels to eliminate noise and dust specks, among other sources of interference;

   - erosions and dilations (19) to connect particles which being single have been separated in the image and to separate those which have been joined;

   - convolutions (20), applying different filters (high pass, low pass), to highlight or to soften different aspects of the image;

- morphological analysis (21) to discover the number of fibres of each colour, as well as other parameters such as size of the fibres, position, centre of gravity or others;

- validation (22) of the image in accordance with a series of rules pre-established so that the program can determine whether the sample analysed is or is not inside the specifications, whereby it is accepted or rejected.

2. Device for the performance of the procedure for control of the previous claim, **characterised in that** therein participate a system of illumination (3) of the paper (1) bearer of the coloured fibrils (2), a camera (4), as means of acquisition of images, and a computer (5) provided with an acquisition card.

3. Device, according to claim 2, **characterised in that** it incorporates a casing (7), provided with an upper platform (8) wherein is established a transparent area (9) for location of the paper (1), under which a luminous panel (10) is mounted, with several fluorescent lamps with radiation in ultraviolet, which illuminates the paper (1) with backlighting, arising from said platform (8) a tower (11) in which is housed, at a lower level a second luminous panel (13), similar to the previous one, in a perpendicular position with respect to the platform (8) and with which a mirror (14) collaborates, said mirror located in the opposed face of the tower (11), preferably in the cover (12) for closing the same, so that through this mirror (14) a frontal and diffuse illumination of the paper is achieved, whilst in the upper area of the tower the video camera (4) is mounted, in a disposition perpendicular to the platform (8) and with its lens accompanied by at least a filter which only allows the visible component of the spectrum to pass, eliminating the infrared and ultraviolet components.

4. Device, according to claims 2 and 3, **characterised in that** the camera (4) is a 3-CCD camera, with adjustment of RGB gain, colour temperature and reference white among others.

5. Device, according to previous claims, **characterised in that** the system of illumination (3-10, 13), is accompanied by a control keyboard (15) which allows general off/on switching and the independent powering of each of the luminous panels (10-13).

6. Computer program for the performance of the procedure of claim 1.

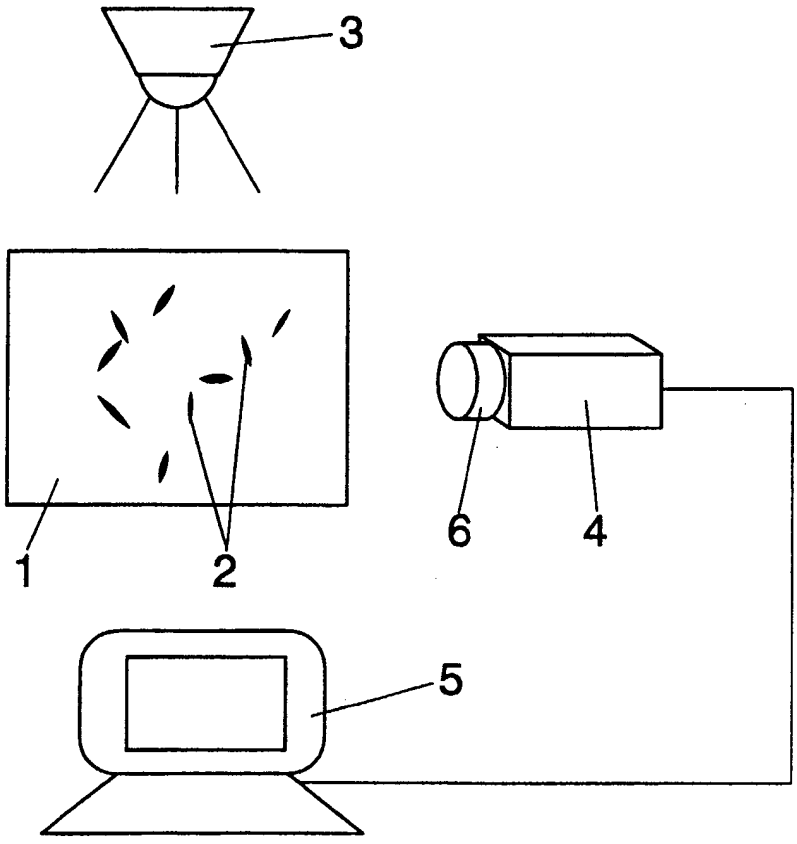

FIG.1

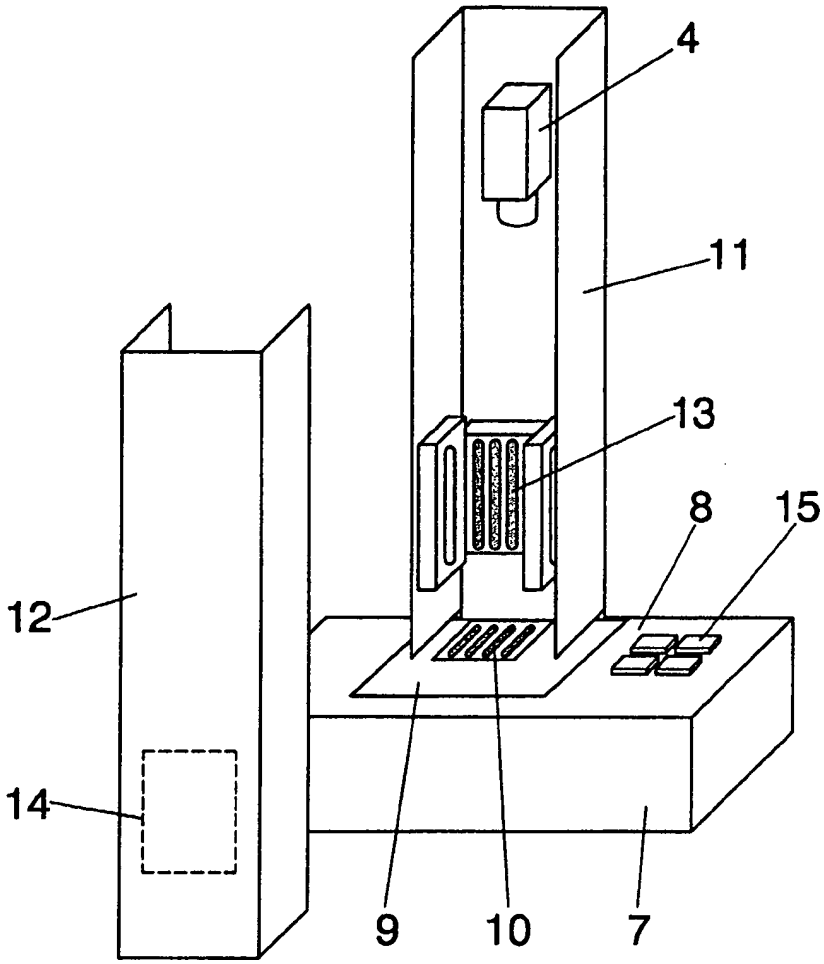

FIG.2

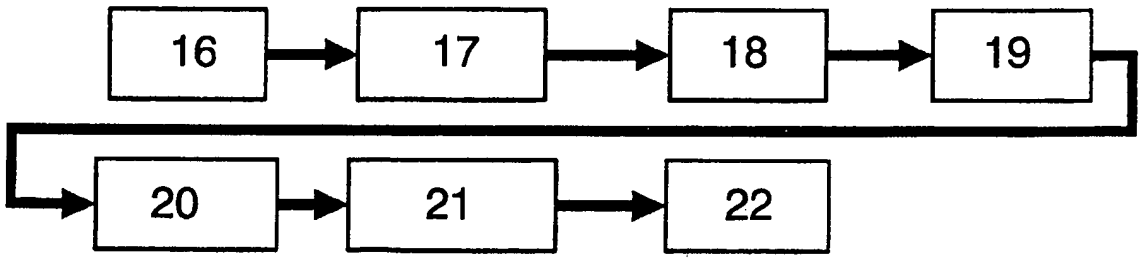

FIG.3

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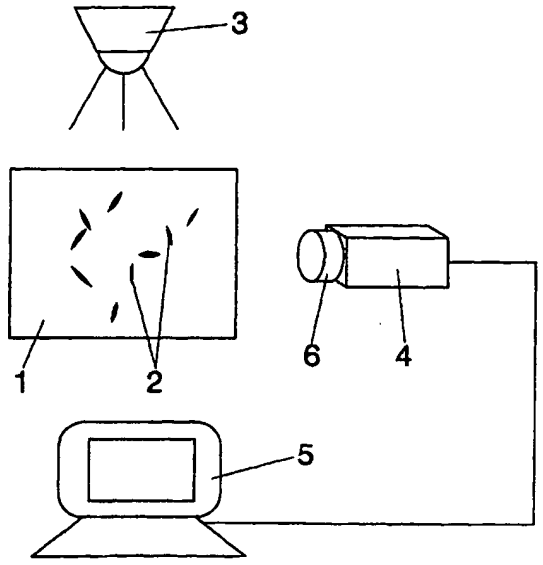

FIG.1

1 300 810 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 02 38 0197

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 974 150 A (KAISH ET AL.) 26 October 1999 (1999-10-26) * column 9, line 3 - column 18, line 54 * * column 19, line 18 - column 26, line 14; figures 1-3 *	1-6	G07D7/12
X	US 3 922 090 A (FAIN) 25 November 1975 (1975-11-25) * column 1, line 37 - column 2, line 21 * * column 2, line 47 - column 7, line 47; figures 1-3 *	1-6	
A	US 6 246 061 B1 (RAMSEY ET AL.) 12 June 2001 (2001-06-12) * column 2, line 11 - column 3, line 50 * * column 4, line 35 - column 7, line 42; figures 1A-8 *	1,2	
A	US 5 719 939 A (TEL) 17 February 1998 (1998-02-17) * column 2, line 48 - column 4, line 21 * * column 4, line 37 - column 6, line 3; figures 1,2 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G07D
A	US 4 075 604 A (DEGASPERI) 21 February 1978 (1978-02-21) * column 3, line 3 - column 13, line 23; figures 1-9 *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 April 2003	Rivero, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 38 0197

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11-04-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5974150 A	26-10-1999	AU 734643 B2	21-06-2001
		AU 9670998 A	23-04-1999
		CA 2304632 A1	08-04-1999
		CN 1279849 T	10-01-2001
		EP 1025665 A1	09-08-2000
		JP 2001518414 T	16-10-2001
		WO 9917486 A1	08-04-1999
US 3922090 A	25-11-1975	NONE	
US 6246061 B1	12-06-2001	US 6035914 A	14-03-2000
US 5719939 A	17-02-1998	NL 9001368 A	02-01-1992
		AT 122968 T	15-06-1995
		CA 2085113 A1	16-12-1991
		DE 69110044 D1	29-06-1995
		DE 69110044 T2	09-11-1995
		DK 533829 T3	24-07-1995
		EP 0533829 A1	31-03-1993
		ES 2074277 T3	01-09-1995
		JP 2793366 B2	03-09-1998
		JP 6503762 T	28-04-1994
		WO 9119614 A1	26-12-1991
		US 5354097 A	11-10-1994
US 4075604 A	21-02-1978	IT 1055430 B	21-12-1981
		BR 7701106 A	18-10-1977
		CA 1074014 A1	18-03-1980
		DE 2706655 A1	01-09-1977
		ES 456560 A1	01-02-1978
		FR 2343290 A1	30-09-1977
		GB 1555206 A	07-11-1979